ABSTRACTS OF PAPERS

PRESENTED AT THE MEETINGS OF THE

AMERICAN MORPHOLOGICAL SOCIETY

AT BALTIMORE, DECEMBER 27 AND 28, 1900.

I. FISSION AND REGULATION IN STENOSTOMUM LEUCOPS.

C. M. CHILD.

THE single individual of *Stenostomum* differs considerably in size, according to conditions. Well-nourished specimens may reach a length of nearly one and one-half millimeters, while specimens measuring only one-half millimeter are often found when food is scarce. The length is about eight or ten times the transverse diameter.

The animals usually occur in chains, the number of zoöids varying from two to nine. Ordinarily chains do not consist of more than five zoöids, the uneven number being due to the fact that the anterior zoöid precedes the others in division. The short chains of two or three zoöids occur when food is scarce. In well-nourished specimens the fissions succeed each other more rapidly, and longer chains are the result. Each particular septum occurs, with little variation, in a definite, characteristic position, this apparently being determined largely by the relative degree of development of the two ends of the zoöid which it divides.

Entodermal tissue is necessary for regeneration. Portions containing all the other tissues of the body except entoderm

do not regenerate, but if a small portion of the entodermal digestive sac be present regeneration is complete, provided the piece is above a certain size.

If a chain be artificially separated into its zoöids before they have attained their full development, each zoöid undergoes a form-regulation, assuming within a few hours what may be called the normal proportions, *i.e.*, the length becomes eight or ten times the transverse diameter. This regulation does not occur while the individual is a zoöid in a chain, because the whole chain is not simply a series of individuals, but in some degree a single individual, and therefore possesses certain proportions differing from those which each zoöid would possess if single.

When the chain is cut at various points between the zones of fission, the results differ according to the degree of development of the particular zone of fission concerned and the parts adjoining it. If a piece containing a very young septum be cut out from a chain, the septum disappears and a single perfect individual is formed from the parts, which originally belonged to two different zoöids. A head is regenerated at the anterior cut surface, a tail at the posterior end. If the included septum be more fully developed, it remains, and the part anterior to it is completely absorbed by the part posterior to it, the head of the new individual resulting being the head which was forming just posterior to the septum. The relative size of the parts anterior and posterior to the septum does not affect the result, unless the posterior piece be very small. It is always the anterior part which is absorbed, never the posterior. If the septum be still more advanced in development, the portion anterior to it is only partly absorbed. It regenerates a new head and becomes a perfect zoöid, though at first it decreases in size, owing to the partial absorption.

In general each zoöid tends to absorb material from the zoöid anterior to it. Each zoöid, however, offers a certain resistance to this absorption, the resistance increasing as it approaches the condition of independent individuality. When the individuality of a zoöid is destroyed or reduced to a lower

degree, *e.g.*, by cutting it in half, the posterior half may be completely absorbed by the zoöids posterior to it.

The sexual individual arises as a zoöid in a chain, but when the sexual organs appear, asexual reproduction ceases. The single sexual individual may, however, attain a length equal to that of the longest chains. The power of regeneration is much less in the sexual than in the asexual condition. Apparently in the former the energy is chiefly directed toward the elaboration of the sexual products.

II. THE OCCURRENCE OF GUNDA SEGMENTATA IN AMERICA.

WINTERTON C. CURTIS.

A SPECIES of *Gunda*, which in its external features seemed identical with the *G. segmentata* of Lang, was found in large numbers at Sandwich on Cape Cod. The internal arrangement is not, however, as regular as Lang describes for *G. segmentata*. From a comparison with Verrill's figure of *Procerodes ulvae* collected in the same region (*Trans. Conn. Acad.*, Vol. VIII, January, 1893), it is probable that the two forms are identical and that Verrill has figured the head incorrectly.

III. SOME DISPUTED POINTS IN THE ANATOMY OF THE LIMPETS.

M. A. WILLCOX.

THE following points were made:

1. The space previously described by Willcox as the nephridium is lined throughout by more or less columnar cells provided with long, delicate cilia and loaded in the fresh condition with dark green granules. The histology lends no countenance to Haller's contention that the posterior part of this sac represents coelom, the anterior nephridium.

2. The space which in most species of *Acmaea* underlies the viscera on the left side in *A. testudinalis* stretches almost across the body, and lacks entirely the ciliated cells characteristic of the nephridium. This negatives the opinion that the space in question is a paired structure whose fellow of the right side is represented by the posterior part of the nephridium.

3. A subradular organ, whose presence in the Docoglossa has been denied, exists in both *A. testudinalis* and *A. fragilis*. It is situated on the underside of the odontophore, just behind the tip of the radula, and is a triangular, somewhat cushion-shaped organ, divided by a V-shaped groove into an anterior and a posterior part. The posterior part is marked by transverse grooves and is covered by tall, columnar epithelial cells, some of which seem to be ciliated, while others are somewhat fusiform and have much the appearance of sense cells. The innervation has not been traced, but no ganglia are to be found in the organ. The subepidermal portion consists of connective tissue with scattered and inter-crossing muscular fibers.

IV. THE HABITS AND LIFE HISTORY OF ARGULUS WITH REFERENCE TO ITS ECONOMIC IMPORTANCE.

CHARLES B. WILSON.

IN the town of Warren, Mass., is a small pond which was stocked with carp and bass several years ago. The fish seemed to thrive well until the fall of 1899, when they began to die off in considerable numbers, with no apparent signs of disease or injury. No clue to the cause of the devastation could be obtained till the spring of 1900, when several suckers were speared in the outlet of the pond whose gill chambers were full of the parasitic copepod *Argulus*, probably *A. catostomi*. The gentleman who owned the pond stated that these copepods were common on most of the fish caught there, and his statement was afterward verified. On being put in an aquarium with dace, roach, and bream, they attacked these fish

viciously and the next morning they were found dead. *Argulus* deposits its eggs instead of carrying them around like other crustaceans, arranging them in rows on sticks, stones, etc., with their long diameters parallel.

When laid they are covered with a jelly envelope consisting of beads of jelly arranged in rows parallel with the long diameter of the egg. These harden into a brittle shell. The eggs are fertilized outside the body of the female and there is no copulation. The egg hatches into a typical nauplius, which after one or two moults changes into a metanauplius having highly developed clasping organs in the shape of barbed claws terminating the second maxillae. On putting two small dace into the aquarium with about two hundred of these larvae, the latter made no attempt to use their claspers, but the fish, on recovering from their fright, ate up every one of the larvae. On inquiry it was found that the pond in question had been seined for three years, and that the dace and roach had been sold for pickerel bait. *First conclusion,* the subject of parasitism is not so one-sided as would appear at first sight. *Second conclusion,* the protection of small fish like dace and roach in our fish ponds may be one of the best preventives against such parasites as these.

V. THE ANATOMY AND DEVELOPMENT OF THE POSTERIOR VENA CAVA IN DIDELPHYS VIRGINIANA (KERR, LINN.).

C. F. W. McCLURE.

An examination, thus far, of forty-eight opossums has brought to light many interesting variations concerning the mode of formation of their posterior vena cava.

These variations are so pronounced and so closely accord with certain embryonic conditions described by Hochstetter for *Echidna aculeata,* it seems to the writer as not improbable that the development of the posterior vena cava may take place in *Didelphys* and *Echidna* in substantially the same manner.

In all marsupials hitherto examined (*Petaurus taguanoides* excepted) the posterior vena cava has been found to lie ventral to the aorta between the renal and common iliac veins, and to be formed through a union of the common iliac veins, which takes place *ventral* to the arteries.

In *Didelphys virginiana* the posterior vena cava is not formed in this manner.

In fact, the mode of formation of the posterior vena cava was found to be so variable in *Didelphys virginiana* that it is quite impossible to assign any one mode of origin for this vessel which may be regarded as typical of the species.

For descriptive purposes the various modes of origin of the posterior vena cava in *Didelphys* have been classified by the writer under three main types as follows:

Type I includes those cases in which the internal iliac veins unite with the external iliac veins to form the posterior vena cava, *ventral* to the common iliac arteries or *ventral* to the aorta.

Type II includes those cases in which the internal iliac veins unite with the external iliac veins to form the posterior vena cava, *dorsal* to the common iliac arteries or *dorsal* to the aorta.

Type III includes those cases in which the internal iliac veins unite with the external iliac veins to form the posterior vena cava, both *dorsal* and *ventral* to the common iliac arteries or both *dorsal* and *ventral* to the aorta.

So many variations of this type were met with that a further subdivision of Type III was found necessary, as follows:

Type III, A, includes those cases in which the principal union between the internal and external iliac veins lies *ventral* to the arteries in question.

Type III, B, includes those cases in which the principal union between the internal and external iliac veins lies *dorsal* to the arteries in question.

Type III, C, includes those cases in which the above-mentioned *dorsal* and *ventral* unions are *sub-equally* developed.

The following table shows how the above-mentioned types were distributed among the forty-eight individual opossums examined (twenty-four males and twenty-four females).

Type.	♂	♀	Total.	
Type I	5	9	14	14
Type II	6	7	13	13
Type III				
A	3	2	5	21
B	8	5	13	
C	2	1	3	
Total	24	24		48

A comparison with the development stages in *Echidna aculeata* shows, I think beyond the question of a doubt, that the variations in the method of formation of the posterior vena cava in *Didelphys*, so far as its posterior tributaries are concerned, are modifications of a ground plan arrangement similar to that described by Hochstetter for his *Echidna* embryo No. 45.

The writer's investigations upon the development of the posterior vena cava are as yet incomplete. So far as they have gone, however (an examination of five 15-millimeter embryos), they decidedly favor the above conclusions.

VI. THE CROSSING OF THE OPTIC NERVES IN TELEOSTS.

G. H. PARKER.

In ten species of symmetrical teleosts, in each of which one hundred specimens were examined, the right optic nerve was dorsal at the crossing about as frequently as the left. The two types of crossing (right nerve dorsal and left nerve dorsal) were not correlated with sex and were about equally frequent

in specimens taken from one school of fish. In one hundred specimens of the winter flounder (*Pseudopleuronectes americanus*), whose eyes are on the right side, all had the left nerves dorsal. In seventeen specimens of the summer flounder (*Paralichthys dentatus*), whose eyes are on the left side, all had the right nerves dorsal. In one hundred specimens of the stellate flounder (*Platichthys stellatus*) all had the left nerves dorsal, notwithstanding the fact that fifty of these fish had their eyes on the right side and fifty on the left. Although each species of symmetrical teleosts examined showed about equal numbers of the two possible types of optic nerve crossing, the flounders showed only one type for each species.

VII. A NEW TYPE OF BUDDING IN ANNELIDS.

H. P. JOHNSON.

Two gigantic undescribed species of Pacific coast *Syllidae* produce reproductive zoöids by collateral budding from a definite proliferating region near the posterior extremity.

The single specimen of the larger species (*Trypanosyllis ingens*, sp. nov.) at my command was too poorly preserved for thorough study, but what I have learned about its budding agrees essentially with the fuller knowledge acquired from the other species. The buds numbered about thirty, all turgid with nearly ripe ova. No very young buds were detected, as in the succeeding species.

Of the other species (*Trypanosyllis gemmipara*, sp. nov.) I have several specimens, but only one with buds. They develop from a proliferating region twenty somites anterior to the pygidium. The advanced buds are broadly elliptical, and much flattened dorso-ventrally. Each is attached at its head-end by a short pedicle. The somites number 20–28, with parapodia which are miniatures of those of the parent. The prostomium has large eyes, a pair of antennae, and brain. There are a pair of ventral nerve cords, a muscular system, septa, and large paired masses of sperm cells in every coelomic chamber from

prostomium to pygidium. Purely vegetative organs (*e.g.*, mouth, alimentary canal, anus, and nephridia) are absent, although a rudiment of the alimentary canal may exist as a median strand of tissue extending the length of the bud.

The youngest buds form a cluster of about twenty-five attached to the right side of the zone of proliferation, on its ventral aspect. The earliest-formed organs are the anal cirri, at first two distal protuberances which elongate and become moniliform before the bud segments. Apparently the bud contains only ectoderm and mesoderm, which are continuous with the same germ layers of the proliferating region.

In neither species are there any reproductive cells in the body of the parent anterior to the proliferating region, but sperm cells are present in *T. gemmipara* in the twenty parental somites back of this point.

VIII. AMPHIBIAN STUDIES.

J. S. KINGSLEY.

THE following are the chief points made in the paper:

1. The *Salamandrina* form the central Urodele stem, and the Perennibranchs and Derotremes have been derived from this stem by degeneration and the retention of larval characters.

2. The Urodeles cannot have been the ancestors of the *Anura;* the anuran tadpole resembles the Urodele only in superficial characters; the *Anura* have descended directly from the *Stegocephala.*

3. *Amphiuma* has no tentacular apparatus at any stage; what was described as such by Davison was a trematode parasitic in the suborbital blood vessel.

4. The Caecilians differ from all Urodeles in the fact that the palatine nerve receives a branch from the ophthalmicus profundus instead of from the maxillaris superior nerve.

5. The Caecilians have not descended from the Urodeles, nor is *Amphiuma* a neotaenic Caecilian. The Caecilians are degenerate in loss of limbs and tail; in all other respects they are the most primitive of living *Amphibia.*

6. No Stegocephalan as yet known can have served as ancestor of Urodeles, *Anura*, or Caecilians. The parent form must have possessed characters intermediate between the known *Stegocephali* and the Crossopterygian ganoids.

7. The ancestry of the *Amphibia* must be sought in the *Crossopterygii* and not in the *Dipnoi*.

8. The balancer of the Urodele larva is a modified external gill belonging to the hyoid arch.

IX. PHAGOCYTOSIS IN A MAMMALIAN OVARY.

MAYNARD M. METCALF.

IT has long been known that in the ovaries of certain Mammals and Fishes syncytia of young ova are found, and that of the several nuclei in such a syncytium one or but few persist as nuclei of definitive ova. Apparently, in these cases, the cells which disappear are used as food for the persistent ova.

In the ovary of the common Cat somewhat similar conditions have been observed by the author. Many of the young ova, in the stage when they are surrounded by a follicle consisting of but two layers of cells, are seen to have ingested many of the follicle cells, and the nuclei of these ingested cells can clearly be seen, some quite perfect (newly ingested), others apparently in different stages of digestion. The nuclei of these ingested cells, when almost completely digested, appear as groups of granules, these granules being apparently the remnants of the nodal thickenings of the chromatin network of the ingested cells. Such an ovum with its ingested nuclei very closely resembles the young blastomeres of a *Salpa* embryo, which have the same habit of devouring follicle cells.

Many young ova with ingested follicle cells were found in one Rat ovary. In another ovary of a White Rat no ingestion of follicle cells was found, nor was ingestion found in the ovary of a Gray Squirrel examined. Pressure of other duties has prevented the author from determining if such ingestion of follicle cells be normal in the ova of Rats and, if so, what

relation, if any, it may have to the age of the individual or to its condition as regards reproduction. The observations are reported in the hope that other observers may have them in mind. If the phenomena are at all general among *Mammalia*, they should be seen in many laboratories in the usual histological demonstrations.

Similar phenomena are, of course, well known in several groups of *Invertebrata*.

X. THE MAMMALIAN LOWER JAW.

W. H. RUDDICK AND J. S. KINGSLEY.

IN no adult mammal, recent or fossil, is the lower jaw known to consist of more than a single bone, and no author, save W. K. Parker, whose observations appear to have been overlooked, has shown the existence of more elements in its development. We are able to confirm Parker in his account and to identify in the mammals the following bones of the non-mammalian groups: (1) articulare, (2) angulare, (3) splenial, (4) dentary. Of these, articulare and angulare unite to form the malleus, while the definitive lower jaw is composed of dentary and splenial. Two cartilages participate in the formation of the lower jaw, — the Meckelian and a second larger cartilage lying external to this, which, like Parker, we homologize with one of the lower labials of the *Ichthyopsida*. In its ossification this cartilage is strikingly similar to amphibian cartilages, and the resulting bone — a part of the dentary — gives rise to the posterior part of the lower jaw, including the coronoid and articular processes. In the existence of this lower labial is to be found the explanation of the shifting of the articulation of the lower jaw. It is noteworthy that a lower labial occurs in about the same position in the ganoid *Polypterus*.

XI. AN APPARATUS IN THE CENTRAL NERVOUS SYSTEM OF VERTEBRATES FOR THE TRANSMISSION OF MOTOR REFLEXES ARISING FROM OPTICAL STIMULI.

PORTER EDWARD SARGENT.

IN *Amia*, at about the time of hatching, there arises in the anterior portion of the roof of the optic ventricle a group of cells, eighty to one hundred in number, formed by the differentiation of indifferent neuroblasts. During the first and second days of larval life the axons develop from these cells as exceedingly fine processes, growing directly toward and into the optic ventricle. Early in the third day the adjacent axons come together in groups and coalesce at their tips, in their further growth through the cerebro-spinal fluid appearing as a single fibril. Later these fibrils coalesce with others similarly formed, and in their growth posteriorly through the ventricles and canalis centralis form what has been known as Reissner's fibre, which is then a fibre tract made up of many axons closely united and surrounded by a single medullary sheath. Through the posterior portion of its course there come off from it fine fibrils which pass through the canal obliquely backwards and enter the tissue of the cord.

In the first day after hatching there may be found in the extreme posterior end of the canalis centralis a number of small cells, three to four micra in diameter, lying in the lumen of the canal and ventriculus terminalis. Some eight to ten of these cells persist and continue to develop. Increasing rapidly in size, they become spindle-shaped and send their axons cephalad through the canal. The axons are at first separate, but later coalesce as they grow forward, and, eventually meeting the system of axons from the cells of the tectum growing posteriorly, the two interweave in a way not yet clearly made out.

The development of this apparatus in *Amia* is typical of its development in all vertebrates, though in some groups

there are considerable variations. In the Skate the cells are of conspicuous size, and three to four hundred in number. They are multipolar, sending processes to the ectal portion of the tectum, where they come in direct contact with the endings of the optic nerve fibres and give rise to two fibre tracts, one of which passes posteriorly to the cerebellum, the other anteriorly and out into the optic ventricle to form the Reissner's fibre. In reptiles and birds the apparatus appears at a late stage and is not fully established until just before hatching.

In *Petromyzon* this apparatus is not fully established until the second month of larval life. The cells, about twelve in number, form a well-marked nucleus. Reissner's fibre passes through the optic ventricle, reënters the brain tissue, and again emerges into the fourth ventricle. Thus *Petromyzon* furnishes the connecting link between the condition in the Gnathostomes and *Amphioxus*. In the latter the largest and most anterior of the colossal dorsal cells lies across the central canal, is in direct connection with the pigment spot, and sends its axon caudad through the cord in the median plane just ventral to the canal. This axon probably represents Reissner's fibre.

There are many lines of evidence which lead me to assign the function I have to this apparatus.

1. The cells are in direct connection with the endings of the optic nerve, and with the cerebellum. The axons pass by the shortest path posteriorly through the central canal, and probably out through the ventral roots to the musculature.

2. When the fibre is cut in Sharks or Dogfish they evidence an inability to respond quickly to optical stimuli.

3. In the vertebrates of the cave fauna the apparatus degenerates as the eye degenerates.

4. In no animal does the apparatus reach complete development until just before the animal attains free life.

5. In those animals which are sluggish at hatching (*Petromyzon, Amia*), the apparatus is not fully developed until a considerably later period.

6. In those mammals which are born blind (Mouse, Kitten), the apparatus is not fully established until about the time the eyes become functional.

7. In any one group, as the Teleosts, the apparatus has its highest development in those species which are most active.

8. The corpora quadrigemina of higher vertebrates are concerned only with reflex functions; therefore this apparatus must have a reflex function.

Such a short circuit avoiding the loss of time in passing through a chain of neurones must be of great importance in saving time, amounting perhaps to a considerable fraction of a second. An animal suddenly presented with some optical evidence of danger from which it recoils in fear, does so reflexly, calling into use this apparatus. When we consider that in the struggle for existence the saving of a fraction of a second is often a matter of life or death, it becomes evident that this apparatus has played an important part in the survival of the fittest, and in the whole evolutionary process throughout the vertebrate series.

XII. THE SIGNIFICANCE OF THE SYNAPSIS STAGE OF THE GERM CELLS.

THOS. H. MONTGOMERY, JR.

IN the germinal cycle of the *Metazoa* may be distinguished in succession the following main stages: the conjugation of the maternal and paternal cells (fertilization), a number of generations of ovogonia (or spermatogonia), then the growth period, and finally the stage of the two maturation divisions. The reduction in the number of the chromosomes, *i.e.*, the formation of bivalent chromosomes, is not effected by either of the maturation mitoses, but during that portion of the growth period known as the synapsis stage. The bivalent chromosomes are formed by a union, end to end, of every two univalent chromosomes, as I have shown in a paper on the spermatogenesis of *Peripatus*, just published, and in another on the spermatogenesis of the *Hemiptera*, now in press.

Heretofore no one has shown exactly how the bivalent chromosomes are produced, and no one has given any adequate

explanation for the reason of their formation. My comparative studies on the spermatogenesis of a considerable number of species of *Hemiptera*, which have brought to light certain facts of importance for determining these questions, render it probable that in the process of formation of the bivalent chromosomes we have a conjugation of paternal with maternal chromosomes. This would then be the final stage in the fertilization of the germ cells; it would be a conjugation of the chromosomes of different parentage producing a rejuvenation of them as metabolic centers of the cell; and this rejuvenation finds its expression in the great changes of the growth period. Then, probably, the reduction division takes place, in order to separate again the conjugating chromosomes, as two conjugating *Infusoria* unite and then separate after the accomplishment of the rejuvenescence.

In the space of a short abstract it is not possible to give the evidence for these conclusions.

XIII. A STUDY OF THE PHENOMENA OF FERTILIZATION AND CLEAVAGE IN ETHERIZED EGGS.

EDMUND B. WILSON.

A.

If fertilized eggs of *Toxopneustes*, after the formation of the cleavage-figure, be placed in a 2.5% solution of ether in sea water, the astral rays quickly fade out, as was long since observed by O. and R. Hertwig in sea-urchin eggs treated by solutions of chloral hydrate or sulphate of quinine. The clear hyaloplasm masses forming the astral centers are thus left as well-defined, slightly irregular, non-radiate areas, connected by the spindle-area. If the eggs are replaced in sea water, the rays are rapidly redeveloped and cleavage may proceed nearly or quite normally. Even if left in the ether solution, however, the nuclear division may be completed, the daughter-nuclei being re-formed and growing to their normal size, *but no cytoplasmic division occurs*, — a result similar to the earlier

ones of Demoor on the division of plant cells *in vacuo*, or in an atmosphere of CO_2, and to those of Loeb and Norman on *Arbacia* eggs in sea water concentrated by the addition of a small percentage of chloride of sodium or magnesium. If the strength of the ether solution be now somewhat reduced, by evaporation or by the addition of sea water, the asters reappear, though not attaining full development, and progressive nuclear division may occur without cytoplasmic cleavage. In this case the egg may give rise to a syncytium, containing from four to sixty-four or more nuclei, which migrate towards the periphery so as to take up nearly the same position as they would have had in a segmented blastula. This phenomenon strikingly recalls that which normally occurs in the cleavage of many arthropod and some coelenterate eggs. At each nuclear division an attempt is made at a corresponding cytoplasmic division, but this is usually unsuccessful; or, in case division occurs, the cells subsequently fuse together to repeat the attempt at the next nuclear division. This, again, is closely similar to the ineffective early attempts at cleavage in such eggs as those of *Renilla*. If the eggs be replaced in sea water when the process is not too far advanced (4–32 nuclei), cleavage may occur of a multiple type almost exactly like that occurring in *Renilla*, and a normal blastula may arise; but the cleavage is often irregular or incomplete.

These observations support the conclusion indicated in the preceding paper, that the astral rays are not fixed and permanent structures, but an expression of a form of cytoplasmic activity, partly in the nature of protoplasmic currents, that may be inhibited by temporary paralysis of the cytoplasm. They indicate also that the astral rays are connected with cytoplasmic rather than with nuclear division, and support the interpretation, offered by the author many years ago, of the variations of cleavage observed in *Renilla*.

B.

If *Toxopneustes* eggs be placed in 2.5% ether solution one minute after fertilization, formation of the sperm-aster is completely suppressed. The sperm nucleus, however, slowly moves

inwards and gradually enlarges, becoming finally (1–2 hours) as large as the egg nucleus and indistinguishable from it. In some cases, though this is not very common, the two nuclei approach and finally completely fuse to form a typical cleavage nucleus. If in the earlier stages of the process (before union of the germ nuclei and while the sperm nucleus is still not more than two-thirds the diameter of the egg nucleus) the eggs be replaced in pure sea water, the sperm-aster is rapidly developed, centering in a point at one side of the sperm nucleus, and development may proceed normally; but this result was never obtained after the germ nuclei had united, probably because the action of the ether had been too prolonged. In a few cases, after replacing the eggs in sea water, the sperm-aster was observed to divide and form an amphiaster before union of the germ nuclei. In this case the sperm nucleus at the time of union had assumed the vesicular form, though still somewhat smaller than the egg nucleus. One such case was followed out and found to give rise to a normal larva. In such cases the effect of the ether has been to transform the type of fertilization from that characteristic of the sea urchins into that observed in starfishes, or in many worms and mollusks, where an amphiaster is formed before union of the germ nuclei and the latter are approximately equal at the time of union.

The foregoing facts show, in general accordance with the early work of O. and R. Hertwig, that growth of the sperm nucleus and approach and fusion of the germ nuclei may take place quite independently of the sperm-aster; further, that approach of the nuclei is probably not a simple chemotactic phenomenon, since it is very greatly delayed by etherization of the egg.

C.

In some of the etherized eggs, after replacement in sea water, the nucleus failed to divide at the first cleavage, the whole of the chromatin passing to one pole and re-forming as a single nucleus. Such eggs divide into a nucleated and a non-nucleated half, the latter containing only an aster, as in the case of some of the non-nucleated egg fragments fertilized

by a single spermatozoön observed by Boveri. In such cases the asters in both halves multiply progressively at the same rate, but complete division occurs in only the nucleated half. In the non-nucleated half, however, each aster becomes surrounded by a deep constriction which afterwards fades out. This result stands intermediate between those of Boveri and Ziegler. As in the case of the magnesium eggs, an aster unaccompanied by nuclear material forms a division center of the surrounding cytoplasmic area, but is here apparently unable to effect complete division in the absence of chromosomes.

XIV. EXPERIMENTS UPON THE INFLUENCE OF THE SEXUAL CELLS UPON THE SOMATIC CELLS.

GEORGE WILTON FIELD.

1. *Of the sexual cells of one individual upon the somatic cells of another individual.*

This is generally held to be a phase of Telegony. Several instances have been cited by Gadow, Nathusius, and Bulman to show that the spermatozoa affect the somatic cells which secrete the eggshell. Thus, the shell of eggs of fowls which normally lay brown eggs are said to become lighter in color when the birds are mated with a male of a breed which lays white eggs; and conversely, white eggs become brownish, if the birds are mated with a male of a breed which lays brown eggs.

Our experiments were carried on at the Rhode Island Agricultural Experiment Station upon Leghorn pullets (white eggs) mated to a Light Brahma cock, and upon Light Brahma pullets (brown eggs) mated to a Leghorn cock. By means of trap nests the series of eggs laid by each individual was followed; no departure from the ordinary normal color of the eggshell could be observed.

2. *Of the sexual cells upon the somatic cells of the same individual.*

In addition to observations upon the changes in the secondary sexual characteristics induced by castration, the effect of absorption of testicular material through the peritoneum was the end in view.

Upon castration the testes of the cockerel were returned free into the abdominal cavity. After six weeks a living ripe testis, one inch long, was introduced into the abdominal cavity through an incision anterior to the last pair of ribs. The experiment was conducted on a scale too small to absolutely determine how far the results were due to direct regeneration of the testes, and how far to absorption of the introduced testicular material. Two points, however, were demonstrated: (1) that the testes do regenerate; (2) that the introduced testicular material was absorbed. In one case it seemed clear that the secondary sexual characteristics developed solely as the effect of the absorption of the introduced testicular material, without regeneration of the testes. In another individual similar conditions were strongly indicated, but were obscured by a pathological growth.

XV. THE MORPHOLOGICAL PHENOMENA INVOLVED IN THE CHEMICAL PRODUCTION OF PARTHENOGENESIS IN SEA URCHINS.

EDMUND B. WILSON.

In accordance with Loeb's important discoveries on *Arbacia*, unfertilized eggs of *Toxopneustes*, when treated by the magnesium chloride method, may segment and give rise to free-swimming blastulas, gastrulas, and Plutei. There is always a considerable proportion of abortive and monstrous forms, and none of the stages are exactly like those arising from fertilized eggs, though often closely similar to them. The Plutei possess, however, the characteristic arms, pigment, skeleton, and divisions of the gut. That these eggs have not been accidentally fertilized is proved by the fact, demonstrated to the society by an exhibition of sections, that during cleavage they

show but half the usual number of chromosomes, namely, eighteen instead of thirty-six. The same conclusion is reached by the study of the other internal phenomena, which differ in a characteristic way from those occurring in normal fertilization, though showing an interesting parallel to them.

The eggs, even of the same individual, show a very high degree of variability in their response to the solution. Great numbers of incomplete or abnormal forms of mitosis occur. The most interesting of these are cases in which the nucleus becomes the center of formation of a single aster (monaster), which never resolves itself into an amphiaster but nevertheless passes through periodic changes parallel to those occurring in complete mitosis. Thus, such an aster may appear, nearly disappear, and reappear as many as six times in succession, the nucleus simultaneously disappearing and re-forming. In such cases the chromosomes divide, probably at each disappearance of the nucleus, and may thus become very numerous, without division of the nucleus or of the cell body. In other forms of incomplete mitosis the single aster may give rise to an amphiaster, but the nucleus fails to divide.

In all the eggs capable of development, the initial change is an irregularity in the cytoplasmic meshwork, followed by the appearance of a *primary radiation* centering in the nucleus, the gradual formation of a perinuclear clear zone of hyaloplasm, and the growth of the nucleus. In many of the eggs a number of separate asters (cytasters, equivalent to the "artificial astrospheres" of Morgan), having no direct relation to the nucleus, are formed in the cytoplasm in addition to the primary radiation. At the centers of these asters hyaloplasm likewise accumulates. Growth of the nucleus is followed by disappearance of the nuclear membrane, the rays of both the primary radiation and of the cytasters meanwhile becoming much reduced and in some cases nearly disappearing. After a short pause this is followed by a redevelopment of the rays, and in typical cases the nuclear area (the center of the former primary radiation) has now formed two centers of radiation, producing a typical amphiaster. When no cytasters are present (a relatively rare case) cleavage may proceed nearly as in

normally fertilized eggs, but in many cases complete cytoplasmic division does not occur until after two or more nuclear divisions. Thus arise some of the forms of multiple cleavage observed by Morgan and Loeb. If cytasters be present, one or more of them may participate in the nuclear division, thus forming triasters, tetrasters, etc.; but such eggs are probably incapable of producing an embryo. When the cytasters do not establish a connection with the chromosomes, they nevertheless form, in many cases, ineffective centers of cytoplasmic division, *i.e.*, cleavage furrows appear between them but afterwards fade out. Apparently strong evidence was, however, obtained that in some cases complete division may occur around asters unconnected with nuclear material. In any case the cytasters persist for some time and may progressively multiply by division. The first division actually observed takes place nearly synchronously with that of the cleavage asters, at a time when the daughter-nuclei have been formed and are rapidly enlarging. Division of the asters is in both cases preceded by a great reduction of the astral rays, leaving the clear hyaloplasmic central mass surrounded by only short irregular rays, and at the same time the aster migrates out towards the periphery of the egg. The mass then draws apart into two, and recrudescence of the rays from the two centers ensues. A discrepancy, not yet fully cleared up, lies in the fact that, although the cytasters divide synchronously with the cleavage asters, they have not been observed in the living eggs to divide at the time the dicentric nuclear figure is first formed; but the study of sections indicates that this is probably owing to a gap in the observations. The cytasters ultimately disappear.

Asters are formed also in *enucleated fragments*, obtained by shaking the unfertilized eggs into pieces, and such asters may also progressively divide, though no case was observed of cleavage, or even an attempt at cleavage, in such fragments. Sections show that all the asters, whether cytasters or nuclear asters, or those formed in enucleated fragments, contain centrosomes which have the typical staining capacity and granular structure observed in normally fertilized eggs. In the cytasters, however, they are usually smaller than in the nuclear

asters, and those in the enucleated fragments are smaller still and often not demonstrable.

The observations indicate that the astral rays, whatever be their other functions, are in part an expression of centripetal currents of hyaloplasm (continuous or interalveolar substance), which lead to the formation of the perinuclear hyaloplasmic zone, and of the clear centers of the cytasters — a conclusion essentially in agreement with the early views of Fol. They show further that the asters (centrosomes) must be regarded as centers of cytoplasmic division, though not ordinarily effective unless connected with nuclear material. They seem to leave no doubt, finally, of the formation *de novo* of functional asters and centrosomes, capable of division, and show that such formation may be entirely independent of the nucleus.

XVI. METAMORPHOSIS IN THE HERMIT-CRAB.

M. T. THOMPSON.

IN *Eupagurus longicarpus* only the first six larval stages are distinct: the four zoëas, the important glaucothoë, and the first of the adolescent stages. In the zoëas and the early part of the glaucothoë stage, the "livers" or midgut diverticula are cephalic and thoracic. There are two pairs of these; a pair of *Lesser Lobes* opening dorsally into the stomach, and a pair of somewhat four-lobed *Greater Lobes* opening laterally into the stomach.

During the glaucothoë stage, however, three of the divisions of the greater lobes become atrophied. The fourth or posterior division, at about the time of the second or third day in the shell, grows back into the abdomen. But the lobe of the right side of the body crosses under the intestine to the left, so that both lobes lie on the left of the intestine, which is thrown to the right. At this time the bladders of the Green Glands also migrate into the abdomen. Then the appendages which will be lost become atrophied, and the body musculature alters to the adult type. So the glaucothoë, which was

at first Macruran, attains the Eupagurid structural plan before the moult to the sixth stage occurs.

The duration of the glaucothoë stage is dependent on the time of entering the shell. Specimens which take the shell within the first twenty-four hours after the moult from the fourth zoëa, spend only *four* or more often *five* days in the stage. A delay of four days before the shell is taken prolongs this period to *six* or, in a few cases, to *seven* days. In fifty glaucothoë kept without any shells, some remained in the stage the minimum *four* days, but the majority remained *six* and *seven* days, and one remained *eight* days.

The sixth and following stages introduce no important changes in structure, except the branching of the liver. In this branching, however, the majority of the diverticula of the right lobe go to the right under the intestine, so that this lobe, *in the adult*, apparently lies on this, its own side, of the intestine. The lesser lobes branch later and finally form a small tuft of tubules on each side of the stomach.

XVII. ESSENTIAL FACTORS IN THE REGENERATION OF PLANARIA MACULATA.

CHARLES RUSSELL BARDEEN.

REGENERATION of a new whole individual from a small piece of a parent individual depends in *Planaria maculata* upon the presence in the piece of a part of the central nervous system and a part of the intestinal system. A small piece containing these parts will regenerate from them new typical intestinal and nervous systems. At the same time the parenchyma in the vicinity of the cut surface becomes increased in amount, and is symmetrically differentiated in relation to the new intestinal system. A head may thus be formed anterior to a new axial gut, and lateral and tail areas may be restored. Polarity of the piece is determined by the central nervous apparatus which it contains.

A new pharynx is formed just posterior to the point where intestinal contents collect when the whole piece contracts.

The pharynx may be formed in a region of the piece at some distance from the cut surface. Head, lateral, and tail areas are differentiated only at a cut surface.

The reproductive organs are not regenerated. Instead, they disappear from a small piece isolated from a sexually mature worm. The tail cut from a planarian in which the reproductive organs are developing will give rise to regenerative forces which overpower the forces giving rise to the sexual organs. Regeneration is equally rapid in sexually mature and in sexually immature worms.

In regeneration in this animal the tissues seem to be specific, except that the new musculature probably comes from parenchyma cells.

A full account of the Physiology of Regeneration in these animals is given in the *American Journal of Physiology*, Vol. V (1901), p. 1.

XVIII. THE HISTOGENESIS OF THE PERIPHERAL NERVOUS SYSTEM IN SALMO SALAR.[1]

ROSS GRANVILLE HARRISON.

CELLS provided with pseudopodia-like processes wander out singly from the dorsal surface of the medullary cord, and collect together between the myotomes and the cord into small groups, the spinal ganglia. Here the cells remain for some time undifferentiated, but are transformed later into bipolar cells, of which the centripetal processes grow into the side of the medullary cord to form the dorsal roots.

Neuroblasts may be distinguished at an early stage as round or polyhedral cells, lying in the outer zone of the cord. At this period the cord is made up chiefly of epithelial cells, the forerunner of the ependyma. These cells are still undifferentiated, no specialized "*Randschleier*" being present. As the axones grow out from the neuroblasts, they bore their way

[1] A full account of this work is published in the *Archiv für mikroskopische Anatomie*, January, 1901.

through the substance of the epithelial cells, which with the continued growth of new fibres become more and more honeycombed. Their outer zone is finally transformed into a fibrous framework, the "*Randschleier*," which accordingly owes its structure to the activity of the growing nerve fibres, and is not pre-formed.

The dorsal cells or giant cells of Rohon arise in the dorsolateral portion of the cord next the outer limiting membrane. They elongate, and for the most part each cell gives rise to an ascending and a descending nerve fibre forming the beginning of the dorsal funiculi. Gradually the cells leave their original position and wander to the dorsal mid-line of the cord. Through this movement the cells become unipolar, remaining connected with their fibres by a slender process, which divides in T-fashion at the point where the longitudinal fibres begin. A large number of the cells form peripheral nerves also, which are segmentally arranged. The dorsal cells are homologous with the "*Hinterzellen*" found in *Petromyzon*, and with the bipolar cells of medium size in the cord of *Amphioxus*. They are to be regarded as a primitive type of sensory cell identical in function with the spinal ganglion cells, with which they are genetically related.

XIX. THE SPERMATIC AND MESENTERIC ARTERIES OF DIDELPHYS VIRGINIANA (KERR, LINN.).

C. F. W. McCLURE.

In mammals other than marsupials the anterior mesenteric artery supplies the small intestine and the proximal end of the large intestine. The posterior mesenteric artery is given off from the posterior division of the abdominal aorta, and supplies the large intestine. In a large number of mammals the internal spermatic arteries are given off from the aorta about midway between the renal and posterior mesenteric arteries.

In *Didelphys* and other marsupials, so far as known to the writer, the anterior mesenteric artery supplies both the small and

large intestines. In *Didelphys* and other marsupials the posterior mesenteric artery *is not present.* Also in *Didelphys* and other marsupials the internal spermatic arteries are given off from the posterior division of the aorta, and at a point which coincides with the point of origin of the posterior mesenteric artery in other mammals.

In an adult *Didelphys* killed during the breeding season the writer found present two pairs of functional internal spermatic arteries. The anterior pair was given off from the aorta about midway between the renal and posterior pair of internal spermatic arteries. The posterior pair, the so-called internal spermatic arteries of marsupials, was given off from the aorta in the usual manner, as mentioned above. More recently the writer has found another adult female *Didelphys*, in which, in addition to two pairs of internal spermatic arteries, a large *posterior mesenteric artery was present.*

In this individual the posterior mesenteric artery arose from the aorta as a single vessel, and at a point which coincided with the origin of this vessel in other mammals. On arising from the aorta the vessel passed ventrad through a foramen in the vena cava, and was distributed to the large intestine. The anterior mesenteric artery in this individual supplied the small intestine and the proximal portion of the large intestine.

The relations of the spermatic arteries were as follows:

The anterior pair of internal spermatic arteries arose from the aorta, and was distributed to the ovaries as in the above-mentioned case. These arteries appear to be the homologues of those spermatic arteries which in many other mammals arise from the aorta about midway between the renal and posterior mesenteric arteries. The posterior pair of internal spermatic arteries in this opossum were *branches of the posterior mesenteric artery*, and were given off from this vessel near its point of origin at the aorta.

It appears to the writer as though in the marsupials, as the result of an arrested development of the original internal spermatic and the posterior mesenteric arteries, a new collateral circulation has been established to the genital organs

and large intestine. The collateral circulation to the large intestine has apparently been established through the anterior mesenteric artery; that to the ovaries, through vessels which may have been formed as the result of a modification of the posterior mesenteric artery.

XX. SOME FACTS CONCERNING REGENERATION AND REGULATION IN RENILLA.

H. B. TORREY.

DURING the past summer experiments were carried on at Beaufort, North Carolina, preliminary to a more complete investigation of the processes of regeneration and regulation in *Renilla*. It was hoped that *Renilla*, being a polymorphic colonial form, — an *aggregate of polyps and zoöids*, — would behave like a simple metazoan individual, and at the same time offer surer landmarks, during regulative processes, than a metazoan individual — *an aggregate of cells;* for changes in polyps as a whole may be perceived more clearly than changes in their component cells.

The results may be summarized as follows:

1. *Renilla* colonies may regenerate lost parts readily.

2. They exhibit a strong polarity. When a peduncle is removed by a transverse cut an axial polyp is never regenerated in its place, and *vice versa*.

3. There is an anterior limit beyond which anterior pieces do not regenerate posteriorly, and a posterior limit beyond which posterior pieces do not regenerate anteriorly. These correspond to the limits of the budding zone.

4. The colonies regulate themselves in a plastic fashion when cut in certain ways, obliquely, for instance. It is thus possible to obtain two new colonies, one of which retains the original peduncle with a lateral polyp displaced into the position formerly occupied by the axial polyp. Whether or not the colony develops symmetrically around this new axis is not known.

If the oblique cut makes with the colonial axis an angle larger than forty-five degrees, there is no displacement of the lateral polyp, the extirpated axial polyp regenerating as though it alone had been removed by a transverse cut.

5. When a lateral group of polyps is removed by a longitudinal cut, it regenerates a new peduncle approximately at a right angle to the cut surface, and approximately in the axis of the chief lateral polyp of the group. The future of such pieces is unknown. This is a case of heteromorphosis.

XXI. SOME POINTS IN THE BRAIN OF LOWER VERTEBRATES.

J. B. JOHNSTON.

THE central olfactory apparatus of *Petromyzon* presents, in all important features, an extraordinary resemblance to that of *Acipenser*. In *Petromyzon*, on account of the great buccal apparatus, there has occurred a sort of telescoping of the olfactory lobes and areas upon the striatum and thalamus as fixed points. The so-called cortex, described by Friedrich Mayer, is nothing else than the epistriatum.

The cells of the olfactory lobe present more primitive characters in *Petromyzon* than in *Acipenser*. The mitral cells are only slightly differentiated, while the stellate and other cells are very numerous and send their neurites, along with those of the mitral cells, to the olfactory nuclei of the fore-brain. Similar categories of cells have been described in Amphibia (P. R. Cajal) and reptiles (Edinger's "Lobuscortex"), although differently interpreted. The numerous, slightly differentiated cells in the olfactory lobe of *Petromyzon* and *Acipenser* represent the material from which the highly differentiated elements of the olfactory lobe of higher vertebrates have been developed.

Several authors have pointed out the close connection between the cerebellum and acusticum in fishes. The study of the minute structure shows that the cerebellum is derived

directly from the front end of the acusticum. Evidence for this from *Acipenser:*

a. Gross continuity of cerebellum and acusticum.

b. The root fibres of the fifth, eighth, and lateral line nerves enter and end in both.

c. The several categories of types of cells in the cerebellum — Purkinje cells, granules, and cells of the second type — are strictly homologous with similar cells found in the acusticum.

d. The development of the Purkinje cells in the acusticum from the typical large cells of that nucleus is in actual progress and may be studied in all its stages.

Additional evidence in *Petromyzon:*

a. The Purkinje cells in the cerebellum are not well developed, and their neurites run to the base of the mid-brain, possibly having the same destination as the internal arcuate fibres from the acusticum.

b. The *tractus tecto-cerebellaris* seems to be absent and the *tractus lobo-cerebellaris* is small.

c. The cerebellum is little more than a dorsal arch and commissure from the front end of the acusticum.

XXII. ASEXUAL REPRODUCTION OF PLANARIA MACULATA.

WINTERTON C. CURTIS.

THE fission of *Planaria maculata*, while it does not differ essentially from the type found in other planarians where fission occurs, is of just the right sort to complete a very interesting series and connect the fission of land planarians, which is hardly more than a fragmentation, with the fission of *Planaria fissipara*, in which the organs are completely formed before the new individuals separate. This series is as follows: (1) Land planarians, in which pieces of varying lengths are pinched off from the posterior end; (2) *Planaria maculata*, which divides always at the same place behind the pharynx, with no preformation of organs; (3) *Planaria subtentacula*

(Zacharias, *Zeit. f. Wiss. Zool.*, 1886, Bd. XLIII, pp. 271–275), where there is some rearrangement of the gut and the pharynx is partly developed before separation; (4) *Planaria fissipara* (Kennel, *Zool. Jahrb.*, Abth. f. Anat. u. Ontog., 1888, Bd. III, pp. 447–486), in which a complete worm is developed out of the posterior third of a large specimen and both reach normal proportions before separation. In the last three cases the division occurs at a corresponding place.

The division in *Planaria maculata* seems to be brought about by a contraction of the circular muscles, which pinches the individual in two a short distance behind the pharynx. The cut ends of either piece are as though they had been produced by a knife-cut, and examination of sections shows that the parenchyma at the scar is actually naked. There is nothing like a furrow on the outside previous to the division, which, nevertheless, is a regular and normal reproductive process and not induced by any ordinary irritation or mutilation of the animals. The large number of pieces in various stages of regeneration, found in collecting, is sufficient evidence of the occurrence of the fission under natural conditions.

Worms will not divide in the laboratory to any considerable extent unless well fed. If the water has become foul and is replaced by fresh, a considerable number of specimens will usually be found divided within the next twelve hours. The division usually occurs at night, whether the dishes are shaded or not. The morpholaxis of the head and tail pieces resulting from a division is rapid. Tail pieces may reach almost the normal proportions and re-divide in from five to six days if well fed, heads in not less than ten days. There is no regular interval between the divisions.

In certain localities this species does not possess reproductive organs at any time during the year, but has during the summer months an active period of asexual multiplication. In other localities the worms develop these organs in the fall and lay eggs in the spring; and although all the specimens are without these organs at the end of the summer, asexual reproduction has never been observed. In another sexual locality the worms, when they are without reproductive organs at the

end of the summer, do reproduce asexually to a considerable extent. Later this ceases and the reproductive organs develop. These statements are based upon observations extending over from two to three years.

A possible explanation is that the asexual reproduction may be substituted for the sexual in certain localities during considerable periods, but further data are necessary to confirm this.

XXIII. VARIATION AMONG HYDROMEDUSAE.

CHARLES W. HARGITT.

OBSERVATIONS upon variations among the Hydromedusae seem to have been of comparatively limited extent. References to the subject are to be found in the writings of Ehrenberg, Forbes, Agassiz, Hincks, Romanes, and later by Agassiz and Woodworth, but except in the last-named paper they are rather incidental and fragmentary.

Of my own observations only the barest abstract and summary can be undertaken in this connection.

Among the genera studied the principal have been as follows: *Pennaria, Eucope, Obelia, Margelis, Gonionemus, Nemopsis,, Rhegmatodes.*

The principal organs examined were: (1) The Chymiferous Canals, (2) Tentacles, (3) Gonads, (4) Otocysts. Among these the greatest range of variation was noted in the tentacles, as might naturally be expected, in some cases reaching as high as 90 per cent. In the forking and doubling of tentacles there was least, rarely exceeding 5 per cent, and indeed seldom reaching that ratio; in *Gonionemus* 3 per cent.

In the looping, branching, and anastomosing of chymiferous canals there was great variation in different genera, in some being almost *nil*, while in others (*Eucope* and *Gonionemus*) varying from 5 to 10 per cent.

Considerable variation was found in the gonads, though less than in the other organs already noted, varying in different genera from 2 to 5 per cent. While considerable variation

was evident in the number, arrangement and correlation of the otocysts, no attempt has been made to ascertain the exact ratio, owing to the difficulty attending this determination in preserved specimens.

The following summary will express in a general way some of the more evident conclusions reached:

1. Variation among Hydromedusae is of wider extent than had been suspected.

2. It is much greater in some genera than in others.

3. It seems to be much less symmetrical and correlated than among Scyphomedusae.

4. Many phases of variation appear to be wholly devoid of correlative and adaptive aspects.

XXIV. EXPERIMENTS ON MODIFYING THE NORMAL PROPORTION OF THE SEXES IN THE DOMESTIC FOWL.

GEORGE WILTON FIELD.

THIS is a brief report on a series of experimental attempts to ascertain the factors which determine sex.

The normal proportion given by Darwin from observation of 1001 chicks during eight years was 94.7 males to every 100 females. From 2105 chicks during two years, we found the proportion to be 80.6 males to every 100 females.

These figures lead us to query whether the normal proportion may not have changed during the past forty years as a result of the breeders' desire to produce a larger proportion of females.

In the experiments attempts were made to isolate the factors so that the effects of each could be observed:

1. Absolute age of parents:
   - ♀ young females mated to male of same age.
   - ♀ old " " " " " " "

2. Relative age of parents:
   - ♀ old females mated to young male.
   - ♀ young " " " old "

The proportion practically coincided with the normal except in the case of young females mated to old male, where a slight increase in the number of males appears.

3. Malnutrition (a result of feeding to one-half usual amount) : a very marked increase in number of males ; rate of 176.6 males to every 100 females.

4. Scarcity of males, *i.e.*, polygamy : 20 females mated to 1 male, a marked increase in number of males ; 139.6 males to every 100 females.

5. Conditions connected with time of year : 650 chicks hatched between March 15 and May 15 gave a smaller proportion of males, — 73.9 males to every 100 females ; while 471 chicks hatched between May 15 and July 15 gave a larger proportion of males, — 88.4 males to every 100 females.

It is to be understood that these figures are for a relatively small number of cases ; it is hoped to extend them to at least 10,000 individuals.

XXV. NOTES ON VARIATION IN THE SHELLS OF PURPURA LAPILLUS.

R. P. BIGELOW AND H. S. CONANT.

Purpura lapillus is a species that presents great variations in its diagnostic characters. It was thought, therefore, that a study of its variations by statistical methods might be of value in defining more exactly the limits of the species, and might also bring to light facts of general biological interest. Collections were made at Prince's Cove and on the mainland opposite Clark's Ledge, Eastport, at Kennebunk Beach, at Bass Rocks, Gloucester, and at Newport. The sexes were separated for each locality, and the following characters were measured :

(1) Angle of the apex and nuclear whorls, or nuclear angle ; (2) angle of the apex and the last whorl, or adult angle ; (3) total length ; and (4) length of spire from the apex to the posterior margin of the opening of the shell. Record was made also of the presence of (5) imbrications, (6) sutures, (7) ribs, (8) teeth, (9) of the curvature of the columella, and (10) of the weight. Perhaps the most obvious variations are in the color and the thickness of the shell, but no satisfactory method was

found for measuring these quantities. A special instrument is being constructed which, it is hoped, will overcome the difficulty in regard to thickness.

A preliminary study of the shells from Eastport and Gloucester shows that for characters (1) to (4) the variations may be represented by curves that are approximately normal. The curves for the two stations at Eastport fit together pretty closely; while they differ distinctly from the curves for the Gloucester specimens, the difference of the means being greater than the standard deviation for each locality. In each case the female shells showed, on the average, a wider angle and a shorter spire expressed in per cent of total length, than the corresponding males, and the same is true for the Gloucester shells as a whole compared with the Eastport shells.

As a measure of variability the coefficient of variation $\left(cv. = 100\frac{\sigma}{m}\right)$ gives contradictory results and appears not to be applicable to measurements expressed in degrees of a circle. Judging from the standard deviations, the shells from Gloucester are somewhat more variable than those from Eastport. The relative variability of the males and females differs for the different characters, and for the same characters in different localities. In general, the females appear to be slightly more variable than the males.

XXVI. VARIATION AND ELIMINATION IN PHILOSAMIA CYNTHIA.

HENRY E. CRAMPTON.

SOME of the results were presented of a statistical study in the case of a large Saturnid moth, *P. cynthia*, of the variability of eliminated and surviving pupae and imagines. From a lot of nearly 1100 cocoons, only 310 living pupae were obtained; 632 contained dead pupae; while the remainder were shriveled or otherwise abnormal larvae or pupae. The living pupae were compared with an equal number of dead pupae with reference

to certain body characters: length, length of bust (to fifth abdominal segment), width and depth of bust, frontal stature of bust (ratio of middle to length), and sagittal stature of bust (ratio of depth to length). In addition the length, width, and stature of a typical organ, the left antenna, were determined. From a tabulation of certain bases of comparison — mean, standard deviation, coefficient of variability — it appeared: (1) That eliminated male pupae were on the whole more variable than the surviving males, and that the surviving females were far less variable than the dead ones. (2) Only 180 of the 310 living pupae produced perfect moths. The perfect male moths were from pupae which were far less variable than the others. This condition was reversed in the case of the females, yet the surviving females, though more variable than the eliminated ones, were not as variable as the eliminated female pupae. (3) The males of all groups were more variable than the females.

XXVII. THE ORIGIN OF TENTACLES IN GONIONEMUS.

H. F. PERKINS.

SOME interesting data have been secured from the study of the origin of tentacles in *Gonionemus*, a common Woods Holl hydromedusa. Specimens $\frac{1}{2}$ mm. in diameter having from 8 to 16 tentacles are found in early summer, and in examining these it was seen that there existed a definite relative position of the tentacles and sense organs.

Two pairs of tentacles, the radial ones, are of equal size. The other tentacles and sense organs are regularly graded from large to small, so that it is possible to determine their order of origin.

Looking at the marginal ring from below, in a normal medusa, each newly formed tentacle is seen to lie next to a sense organ and to precede it, as the hands of a watch move. Fig. 1 shows a typical 8-tentacled medusa. Tentacles I and II are radial in position; III follows I in the direction of the

hands of a watch; IV follows II, and the two pairs of sense organs, 1 and 2, lie as if the cells that were to form them had been crowded along to the right by the newly formed tentacles.

In an older specimen (Fig. 2) the successive pairs of tentacles and sense organs have arisen in corresponding positions, as is indicated by the numbers on the diagram. The origin

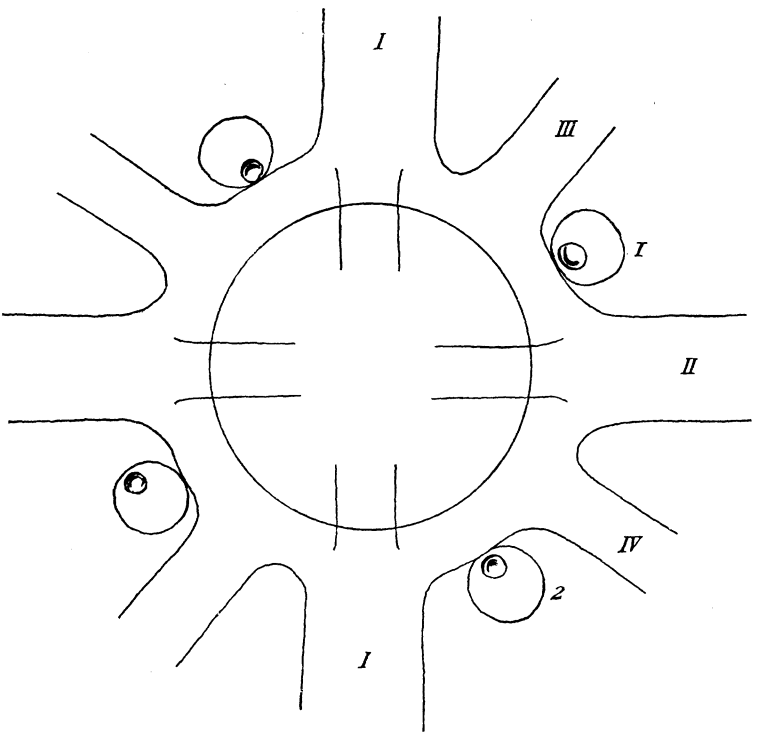

FIG. 1.

of tentacles and sense organs would seem then to be governed by an attempt at radial symmetry which is constantly interfered with by this sequence of formation from left to right, along the bell-margin.

In full-grown medusae there appears a striking conformity to this rule, with fewer exceptions than would be expected from the frequency of other variations in all parts of the creature.

The comparison of other and allied forms, with this rule in mind, may bring to light some interesting facts bearing on the correspondence of parts and on radial and bilateral symmetry.

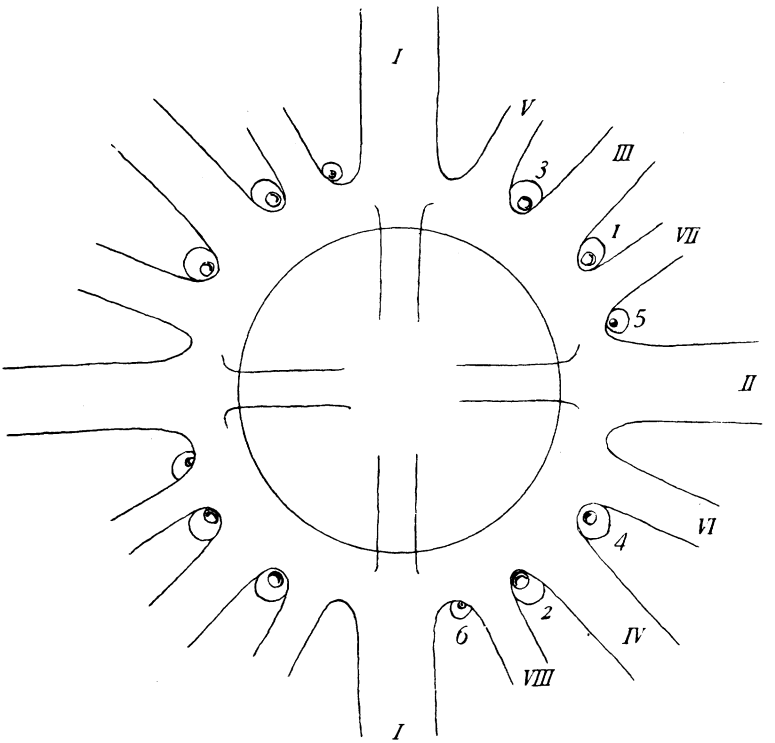

FIG. 2.